427-HW2

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427 Wireless Review

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1 Chapter 1

1.1 Select three of the problems with wireless from page 7. Explain each problem in more detail, as well as how each problem is addressed.

T hree problems with wireless are:

1. Multipath Fading: When a signal bounces around various barriers and adds together resulting in the signal being degraded.

   Multipath Fading is solved with the help of Error control coding, Equalization, and Orthogonal frequency division multiplexing. Error control coding adds extra bits to a signal so that errors caused by multipath fading can be detected and corrected

2. Noise: Any unwanted signal that interferes with the original message signal and degrades the message signal

3. Doppler shifting: The change in frequency or wavelength of the signal due to the motion of the source or destination of the signal.

Here are the solutions to these three problems. Error control coding, adds extra bits to a signal which enables the receiver of the signal to detect and correct the errors. Adaptive modulation and coding dynamically adjust the modulation and coding to measurements of the correct channel conditions. The equalization counteracts the multipath effects of the channel. Other solutions include Multiple-input multiple-output which allows the point of a signal in a concentrated direction, Direct sequence spread spectrum to expand the signal over a bandwidth to reduce signal interference, and Orthogonal frequency division multiplexing which reduces a signal into many lower rate bit streams to reduce multipath problems.

2 Chapter 2

2.1 Define bandwidth.

B andwidth is defined in the textbook as: "The absolute bandwidth of a signal is the width of the spectrum" and a spectrum is defined as "The spectrum of a signal is the range of frequencies that it contains". This means the bandwidth of a signal is the frequency range that the signal is using.

2.2 Compare and contrast analog signals, digital signals, analog data, and digital data.

A nalog data is data that takes on continuous values whereas digital data takes on discrete values. An example would be analog could take on all the numbers through 0-1 including decimals like 0.123 and discrete values can only take on 1's and 0's. Similar to the definitions of analog and digital data, Analog signals are continuously varying electromagnetic waves whereas digital signals are a sequence of pulses that represent discrete values. Some advantages of digital signal over analog is that it is cheaper than an analog signal and is less susceptible to interference. An advantage that analog signal has is that it has a lower attenuation rate compared to digital.

2.3 What is the relationship between wavelength and frequency?

T he relationship between wavelength and frequency can be represented in the equation:

$$\lambda f = c$$

Where λ is the wavelength, f is frequency, and c is velocity which is equal to the speed of light in free space which is approximately $3 \times 10^8 m/s$. This shows that as frequency increases, the wavelength decreases and vice versa.

2.4 Compare and contrast guided media and unguided media. Give special attention to cyber security implications of both.

G uided media are electromagnetic waves guided along a solid medium, such as copper twisted pair, copper coaxial cable, or optical fiber. Unguided media are transmitted electromagnetic signals that are unguided in a given medium such as an atmosphere and space. This transmission is also referred to as wireless transmission. One of the key differences between guided and unguided media is that guided media transmission limitations are heavily reliant on the medium of the signal whereas unguided is heavily reliant on the bandwidth of the signal. Unguided media could lose confidentiality and integrity more easily compared to guided media since it can be easily received by attackers. Whereas guided media is more susceptible to availability attacks since these are primarily physical connections between computers such as wires that could be damaged.

2.5 Solve problem 2.1: A signal has a period of 2 ms. What is its fundamental frequency?

T = 2ms = 0.002s

$$\lambda = \frac{c}{f}$$

$$\lambda = cT$$

$$cT = \frac{c}{f}$$

$$T = 1/f$$

$$f = 1/T$$

$$f = 1/0.002$$

$$f = 500Hz$$

2.6 Solve problem 2.9: Using Shannon's formula, find the channel capacity of a teleprinter channel with a 450-Hz bandwidth and a signal-to-noise ratio of 5 dB.

C = channel capacity (bits/sec) B = Bandwidth (Hz) = 450 SNR = signal-to-noise ratio (dB) = 5 Shannon's formula:

$$C = Blog_2(1 + SNR)$$

$$C = 450log_2(1 + 5)$$

$$C = 450log_2(6)$$

$$C = 1163.233\frac{bits}{second}$$

2.7 Solve problem 2.11: Study the works of Shannon and Nyquist on channel capacity. Each places an upper limit on the bit rate of a channel based on two different approaches. How are the two related?

B oth of these approaches are related to calculating the channel capacity using bandwidth. These equations are related to the premise that doubling the bandwidth will double the data rate and also increase the chance of corrupted bits. For Nyquist, the limitation is due to the effect of intersymbol interference. Whereas for Shannon's equation, the Signal to Noise ratio is the limiting factor.

3 Chapter 3

3.1 Address problem 3.7: Explain the flaw in the following reasoning: Packet switching requires control and address bits to be added to each packet. This introduces considerable overhead in packet switching. In circuit switching, a transparent circuit is established. No extra bits are needed. Therefore, there is no overhead in circuit switching, and, because there is no overhead in circuit switching, line utilization must be more efficient than in packet switching.

T his reason is flawed because it does not consider a variety of other factors that affect line utilization. Some of these factors include how in circuit switching, the channel capacity is dedicated to the duration of a connection, even if no data is being transferred. In addition, in circuit switching the connection provides for transmission at a constant data rate. Thus, each of the two devices that are connected must transmit and receive at the same data rate as the other. Finally, although there are not extra bits needed in circuit switching there is still the overhead of establishing the circuit through requesting connection, linking connection, and establishing the connection, All these factors cause inefficiencies since the capabilities of each computer in a network vary. packet switching resolves these issues and is considered significantly more efficient than circuit switching.

4 Chapter 4

4.1 Answer review question 4.3, "What is a protocol?"

A protocol is a way data behaves by obeying a set of rules or conventions. The key features of a protocol are syntax: the format of data blocks, semantics: control information and error handling, and timing: speed matching and sequencing. Address ports are addresses within a host that have a unique address. This allows data to be delivered to the proper process within the host.

4.2 Solve problem 4.8: A TCP segment consisting of 1250 bits of data and 20 bytes of header is sent to the IP layer, which appends another 20 bytes of header. This is then transmitted through three networks, each of which uses a 16-bit packet header. The destination network has a maximum packet size of 500 bits. How many bits, including headers, are delivered to the network layer protocol at the destination?

d ata = 1250
header size= 160 bits
IP layer append = 160 bits
header = 16 bits
maximum packet size = 500
Total = 1250 + 160 + 160
Total = 1570
Number of packets = 1570 / 500
Number of packets = 3.14 4
This means that we will have to add 16 bits for each package we use thus:
Additional bits from network header per network = 16 * 4 = 64
Total = 1570 + 64 = 1634 bits

5 Chapter 5

5.1 Answer review question 5.12, "Why would you expect a CRC to detect more errors than a parity bit?"

A parity bit is when a bit is appended to a transmission to each 7-bit character such that the character has an even number of 1's or an odd number of 1's. A problem with this approach is that if two bits are inverted due to an error, the error is undetectable. However, for CRC, a block of bits, and a frame check sequence are generated. Making the resulting frame consisting of bits divisible by the same predetermined number. If the receiver divides the frame by that number and there is no remainder, there is no error. I would expect a CRC to detect more errors than the parity bit because the way the CRC can check for errors allows it to detect single-digit and multi-digit inverted errors.

5.2 Solve problem 5.2: It turns out that the depth in the ocean to which airborne electromagnetic signals can be detected grows with the wavelength. Therefore, the military got the idea of using very long wavelengths corresponding to about 30 Hz to communicate with submarines throughout the world. If we want to have an antenna that is about one-half wavelength long, how long would that be?

c = speed of light = 299,792,458
f = carrier frequency = 30Hz

$$lambda = wavelength$$
$$\lambda = \frac{c}{f}$$
$$\lambda = \frac{299,792,458}{30}$$
$$\lambda = 9,993,081.9$$
$$L = \frac{\lambda}{2}$$
$$L = \frac{9,993,081.9}{2}$$
$$L = 4996541$$

L = 4,996,541 meters

5.3 Solve problem 5.4: Stories abound of people who receive radio signals in metal plates in their body. Suppose you have one filling that is 1.25 mm (0.00125 m) long that acts as a radio antenna. That is, it is equal in length to one-half the wavelength. What frequency do you receive?

c = speed of light = 299,792,458

$$\lambda = wavelength = 2 * (0.00125) = 0.0025$$
$$\lambda = \frac{c}{f}$$
$$f = \frac{c}{\lambda}$$
$$f = \frac{299,792,458}{0.0025}$$
$$f = 2.398 \times 1.2^{11} Hz$$